



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MSC INTERNAL NOTE NO. 68-FM-248

68-FM-248

OCTOBER 11, 1968

NOV 3 1969

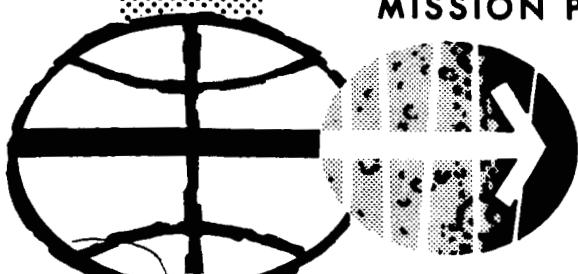
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## MPAD VERIFICATION OF APOLLO 7 FLIGHT MISSION RULES



MISSION PLANNING AND ANALYSIS DIVISION



MANNED SPACECRAFT CENTER  
HOUSTON, TEXAS

(NASA-TM-X-69693) MPAD VERIFICATION OF  
APOLLO 7 FLIGHT MISSION RULES (NASA)  
38 p

N74-70620

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MSC INTERNAL NOTE NO. 68-FM-248

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PROJECT APOLLO

MPAD VERIFICATION OF APOLLO 7 FLIGHT MISSION RULES

By Mission Planning and Analysis Division

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October 11, 1968

MISSION PLANNING AND ANALYSIS DIVISION  
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
MANNED SPACECRAFT CENTER  
HOUSTON, TEXAS

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## FOREWORD

The Mission Planning and Analysis Division (MPAD) has conducted an internal review of the Apollo 7 flight mission rules. Each rule was reviewed with regard to the MPAD's contribution to the creation, verification, or justification of the rule and, also, to the MPAD's agreement or disagreement with the rule.

This document presents the results of the MPAD's internal review and contains the following information about each rule which falls within the MPAD's area of responsibility: background or clarifying statements that may be pertinent as to why the rule was necessary, the data the rule was based on, limitations that exist, if any, etc.; statements concerning disagreements; and a list of references which substantiate the rule. Where disagreement with a rule was discovered, the disagreement was discussed with the responsible flight controller and in most cases was resolved and is so stated.

Rev	Item	<u>ABORT MODE</u>	<u>BOUNDARY OF APPLICATION</u>	<u>PROCEDURES</u>
B	1-68	Mode III	Full lift splash point between 3200 and 8800 n. mi. down range	<p>A. Reference AOH 5.1.2.2</p> <p>B. MCC provides:</p> <ol style="list-style-type: none"> <li>1. GETI at S-IVB cut-off plus 2:05</li> <li>2. Delta V for 3200 n. mi. splash point</li> <li>3. Burn duration</li> <li>4. GET and pitch attitude at 400 K ft</li> <li>5. GET drogue</li> <li>6. GET main</li> </ol> <p>C. Maneuver is SCS auto</p> <p>D. Entry is roll left 55°</p>

**PHILOSOPHY:**

This rule defines the mode III abort region, the MCC voice callups, the burn technique, and entry profile.

**COMMENT:**

Mode III capability does not end at the full lift splash point equal to 8800 n. mi. down range as shown in reference 1. The pitch angle at SPS ignition should also be provided by MCC, as indicated by reference 2. These changes have been discussed with Mr. P. C. Shaffer and are being incorporated in the rules. The rest of the rules are consistent with current procedures.

REFERENCES:

1. Henderson, Edward M.; and Mission Operational Section, TRW Systems Group: Spacecraft Operational Abort Plan for Apollo 7 (Mission C), Volume II - CSM Launch Aborts. MSC IN 68-FM-170, July 19, 1968. (Page 9.)
2. MSC: Apollo Mission Techniques, Apollo 7 Launch Phase Aborts, Techniques Description. MSC IN S-PA-8T-018, July 19, 1968. (Figure 13.)

Date: August 7, 1968

Verified by: E. M. Henderson

Rev	Item	Mode IV	Contingency orbit insertion capability ( $\Delta V < 2200$ fps and $h \geq 83$ NM) to insertion	A. Reference AOH <u>5.1.2.3</u>
B	1-70		<p>MCC provides:</p> <ol style="list-style-type: none"> <li>1. GETI at S-IVB cutoff plus 2:05</li> <li>2. Delta V required to achieve perigee  <math>&gt; 75</math> NM</li> <li>3. Burn duration</li> </ol> <p>C. Maneuver is SCS auto</p>	<p>A. Reference AOH <u>5.1.2.3</u></p> <p>B. MCC provides:</p> <ol style="list-style-type: none"> <li>1. GETI at S-IVB cutoff plus 2:05</li> <li>2. Delta V required to achieve perigee  <math>&gt; 75</math> NM</li> <li>3. Burn duration</li> </ol> <p>C. Maneuver is SCS auto</p>

#### PHILOSOPHY:

This rule defines the mode IV abort region, the MCC voice call ups, and the burn technique.

#### COMMENT:

The pitch angle at SPS ignition should also be provided by MCC as indicated in the reference. This change has been discussed with Mr. P. C. Shaffer and is being incorporated to the rules. The rest of the rule is consistent with current procedures.

#### REFERENCE:

MSC: Apollo Mission Techniques, Apollo 7 Launch Phase Aborts, Techniques Description.  
 MSC IN S-PA-8T-018, July 19, 1968.

Date: August 7, 1968

Verified by: E. M. Henderson

<u>Rev</u>	<u>Item</u>	<u>MODE</u>	<u>BOUNDARY OF APPLICATION</u>	<u>PROCEDURES</u>
B	1-71	Apogee kick	Apogee 3 min from cutoff Velocity > 23 500 Mode IV $\Delta V$ > 100 fps	<p>A. Reference AOH _____</p> <p>B. MCC provides:</p> <ol style="list-style-type: none"> <li>1. GETI for burn at apogee</li> <li>2. Delta V required to achieve <math>&gt; 75</math> NM</li> <li>3. Pitch angle</li> <li>4. Burn duration</li> </ol> <p>C. Maneuver is SCS auto</p>

**PHILOSOPHY:**

This rule defines the apogee kick abort region, the MCC voice callups, and the burn technique.

**COMMENT:**

The apogee kick procedure is not defined in the AOH as indicated, but can be obtained in the reference. The rest of the rule is consistent with current procedures.

**REFERENCE:**

Henderson, Edward M.; and Mission Operational Section, TRW Systems Group: Spacecraft Operational Abort Plan for Apollo 7 (Mission C), Volume II - CSM Launch Aborts, MSC TN 68-FM-170, July 19, 1968.

Date: August 7, 1968

Verified by: E. M. Henderson

Rev	Item	Text
B	2-8	<p>The deorbit capability requirements are:</p> <ul style="list-style-type: none"> <li>A. The capability of SPS deorbit and one alternate method are required.</li> <li>B. SPS deorbit is the prime deorbit method unless specific mission rules are violated prohibiting it's use. For mission planning, sufficient ΔV will be reserved for SPS deorbit (within the entry corridor) from any point in the orbit.</li> <li>C. The SM/RCS allowance for the flight activity prior to the rendezvous assures a 4-quad SM/RCS deorbit capability until the terminal phase of the rendezvous portion of the mission. The SM/RCS single revolution hybrid deorbit then becomes the backup deorbit method.</li> <li>D. For the hybrid technique, the SM/RCS will be used as much as practical and the CM/RCS as little as practical in achieving the target perigee of 40 n. mi.</li> <li>E. In maintaining the hybrid deorbit redline, the following assumption are made:           <ul style="list-style-type: none"> <li>1. A maximum of 80 fps is available from the CM/RCS.</li> <li>2. A minimum of 30 lb in each CM/RCS ring will be reserved for entry attitude control.</li> <li>3. Sufficient SM/RCS will be reserved to supplement the CM/RCS (80 fps) in achieving a 40 n. mi. perigee.</li> </ul> </li> </ul>

PHILOSOPHY:

- B. The reentry corridor limit lines were generated to insure safe reentries for expected  $3\sigma$  variations in L/D, atmospheric models, and latitude effects for the appropriate lift vector and entry mode for different portions of the reentry corridor (refs. 1 and 2).
- D. The actual target perigee may be other than 40 n. mi. since the reentry must be within the operational reentry corridor. The crew will be told by the ground the precise  $h_p$  value for the hybrid targeting maneuver and the corresponding reentry mode.
- E. The maximum effective  $\Delta V$  of 80 fps from the CM RCS pitch deorbit technique leaves 30 lb in each CM RCS during reentry.

COMMENTS:

- B. The final reentry corridors will be defined as L/D variations of significant nature occur prior to lift-off. The next and latest reentry corridors will be defined on or before September 27, 1968.
- D. For precise details refer to reference 3.
- E. For precise details refer to reference 3.

REFERENCES:

1. Gillies, A.: Development of Entry Corridor for the Apollo Near Earth Orbital Missions. TRW note 68-FMT-541.
2. Heath, D. R.: Preliminary Mission C (AS-205/101) Reentry Corridor for Use in the RTCC. MSC memorandum 68-FM53-152, April 12, 1968.
3. Hill, O.: Recommended Hybrid Deorbit Procedures and Final Propellant Budget. MSC memorandum, to be published.

Date: August 7, 1968

Verified by: David W. Heath

Rev	Item	<u>ALTERNATE MISSIONS:</u>													
B	2-31	In general, the details of an alternate mission will be established by the nature of the flight problem. The summary plans are intended to establish the maneuver sequence framework for that flight planning.	<p style="text-align: center;">Summary plan</p> <table border="1"> <thead> <tr> <th>Case</th> <th>Summary plan</th> </tr> </thead> <tbody> <tr> <td>A. S-IVB not available for rendezvous target.</td> <td>A. Perform rendezvous burn sequence at nominal time. Terminate prior to TPI. Continue normal mission.</td> </tr> <tr> <td>B. Rendezvous cannot be performed at nominal time.</td> <td>B. Slip rendezvous sequence 1 day by performing an RCS phasing maneuver at the end of the first day.</td> </tr> <tr> <td>C. Spacecraft problem causes mission termination into Area 6-4 or 18-1 (1 day or less).</td> <td>C. Accomplish as many test objectives, in order of priority, as possible within the constraints of the spacecraft problem, time available, and ground site coverage.</td> </tr> <tr> <td>D. Spacecraft problem detected prior to starting rendezvous sequence which causes mission to be terminated into Area 32-1 (2 days).</td> <td>D. Scrub rendezvous. Perform alternate burn sequence 2B as shown in the operational alternate mission plan. Accomplish as many test objectives, in order of priority, as possible within the constraints of the spacecraft problem, time available, and ground site coverage.</td> </tr> <tr> <td>E. Spacecraft problems which result in mission duration longer than 2 days, but less than nominal end of mission.</td> <td>E. Perform rendezvous at nominal time. Use remaining time to accomplish as many test objectives, in order of priority, as possible within the constraints of the spacecraft problem, time available, and ground site coverage.</td> </tr> </tbody> </table>	Case	Summary plan	A. S-IVB not available for rendezvous target.	A. Perform rendezvous burn sequence at nominal time. Terminate prior to TPI. Continue normal mission.	B. Rendezvous cannot be performed at nominal time.	B. Slip rendezvous sequence 1 day by performing an RCS phasing maneuver at the end of the first day.	C. Spacecraft problem causes mission termination into Area 6-4 or 18-1 (1 day or less).	C. Accomplish as many test objectives, in order of priority, as possible within the constraints of the spacecraft problem, time available, and ground site coverage.	D. Spacecraft problem detected prior to starting rendezvous sequence which causes mission to be terminated into Area 32-1 (2 days).	D. Scrub rendezvous. Perform alternate burn sequence 2B as shown in the operational alternate mission plan. Accomplish as many test objectives, in order of priority, as possible within the constraints of the spacecraft problem, time available, and ground site coverage.	E. Spacecraft problems which result in mission duration longer than 2 days, but less than nominal end of mission.	E. Perform rendezvous at nominal time. Use remaining time to accomplish as many test objectives, in order of priority, as possible within the constraints of the spacecraft problem, time available, and ground site coverage.
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**PHILOSOPHY:**

To establish procedures which will insure accomplishment of critical test objectives when the mission is abbreviated.

**COMMENT:**

Procedures tested are in agreement with MPAD philosophy.

**REFERENCES:**

**Benney, Alexie H., Jr.; and Miller, Samuel L.: Apollo 7 (Mission C) Operational Alternate Mission Report. MSC IN 68-FM-163, July 10, 1968.**

**Date: August 7, 1968**

**Verified by: A. H. Benney, Jr.**

Rev	Item	
B	2-36	<p><u>PRELAUNCH:</u></p> <p>A. The launch window opens at 1500 G.m.t. and closes at 2000 G.m.t. based on the requirement for a fine IMU alignment during the night pass prior to the NSR maneuver.</p> <p>B. The launch will not be attempted if the impact point prediction for mode I abort indicates a beach impact for:</p> <ol style="list-style-type: none"> <li>1. Pad abort</li> <li>2. First 15 sec of flight</li> <li>3. The impact prediction simulation along with its associated support equipment is mandatory for marginal wind conditions, reference rule 3-2.</li> </ol> <p>C. The launch will not be attempted if the minimum ground instrumentation capability is compromised, reference section 3 - ground instrumentation requirements.</p>

**PHILOSOPHY:**

Determine when a lift-off will not interfere with mission constraints or objectives.

**COMMENTS:**

Disagree. Window may close on mode IV lighting or SLA deployment lighting.

REFERENCES:

MSC: Launch Window for the AS/205/CSM-101 Mission (Mission C). MSC memorandum 68-FM64-127,  
April 29, 1968.

Date: August 7, 1968

Verified by: A. H. Benney, Jr.

Rev	Item	The launch phase will be terminated for the following conditions:
B	4-1	<ul style="list-style-type: none"> <li>A. Violation of vehicle breakup line.</li> <li>B. <math>T_{FF} \leq 2 + 20</math> and decreasing after tower jettison.</li> <li>C. Violation of entry "G" limit.</li> <li>D. The <math>\gamma</math> vs V trajectory trace becomes parallel to the "GO" line (<math>h_p = 75</math>) after achieving Mode IV capability</li> </ul>

#### PHILOSOPHY:

This rule defines the launch abort trajectory limits that the Flight Dynamics officer will use to determine an abort for the launch phase. A, B, and C are presented and defined in reference 1. The limit in B was increased from  $1 + 40$  to  $2 + 20$  based on the steep launch profile and the increased entry g's (see ref. 2). The g limit had to be increased above 16g for a portion of the launch to provide an acceptable launch corridor. The g limit that was accepted was in agreement with the proposed limit in reference 3.

#### COMMENT:

These limits are consistent with the current philosophy and in agreement with those endorsed by the Apollo Abort Working Group.

#### REFERENCES:

1. Henderson, Edward M.; and Mission Operational Section, TRW Systems Group: Spacecraft Operational Abort Plan for Apollo 7 (Mission C), Volume II - CSM Launch Aborts. MSC IN 68-FM-170, July 19, 1968.

2. MSC: Results of the Thirty-second Apollo Abort Working Group Meeting on AS-205/101 Held March 26, 1968. MSC memorandum 68-FM36-189, April 29, 1968. (Paragraph 5.)
3. Henderson, Edward M.; and Lunde, Alfred N.: Launch Abort Trajectory Data for Determining the Abort Load Limit for the AS-205/101 Mission. MSC TN 67-FM-178, November 17, 1967.  
(Figures 1 and 2.)

Date: August 7, 1968

Verified by: E. M. Henderson

Rev	Item	
B	4-3	The Mode IV or apogee kick technique is preferred when $h_p < 75$ NM at S-IVB cutoff.

PHILOSOPHY:

This rule simply states that it is more desirable to perform a contingency orbit insertion than a suborbital abort.

COMMENT:

This rule is consistent with the current abort philosophy as in the reference. That is, it is safer to continue to orbit when possible. This procedure allows a better prediction of the landing point and offers a possibility of an alternate mission.

REFERENCE:

Henderson, Edward M.; and Mission Operational Section, TRW Systems Group: Spacecraft Operational Abort Plan for Apollo 7 (Mission C), Volume II - CSM Launch Aborts.  
MSC IN 68-FM-170, July 19, 1968.

Date: August 7, 1968

Verified by: E. M. Henderson

Rev	Item	
B	4-4	<p>Mode II, III, IV, fixed delta V, and apogee kick.</p> <p>A. The ground is prime for abort mode determination and maneuver computation.</p> <p>B. Interrupt maneuvers at <math>t_{ff} = 1 + 40</math> and decreasing. Interrupt mode IV maneuver at <math>h &lt; 75</math> n. mi. and decreasing.</p> <p>C. If entering, utilize lift to avoid land. Crew can always use RL 90° as backup.</p> <p>D. Maximum number of SPS restart attempts is two.</p> <p>E. If no SLA sep or if SPS fails:</p> <ol style="list-style-type: none"> <li>1. <math>h_p &lt; 40</math> - do not burn, CM/SM sep by <math>t_{ff} = 1 + 40</math>. If no SLA sep, execute separation maneuver with SM RCS.</li> <li>2. <math>40 &lt; h_p &lt; 75</math> - Ground will decide to use RCS ASAP or at apogee to reduce <math>h_p</math> to 40 n. mi. Interrupt at <math>t_{ff} = 7</math> min if <math>h_p &lt; 40</math> n. mi.</li> </ol>

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#### PHILOSOPHY:

- B. Any abort SPS maneuver should be terminated if  $t_{ff}$  becomes less than  $1 + 40$  to provide sufficient time for entry orientation. If altitude becomes less than 75 n. mi. during a mode IV the burn is progressing unsatisfactorily and should be terminated.
- C. Aborts with SPS failures could result in African landings. The spacecraft lifting capability is presented in section 4.6 of reference 1 for those situations.

**COMMENT:**

Caution should be used for RL90 entries for very off-nominal flight-path angles because of excessive entry g's. The rule is consistent with the abort techniques outlined in references 1 and 2.

**REFERENCES:**

1. Henderson, Edward M.; and Mission Operational Section, TRW Systems Group: Spacecraft Operational Abort Plan for Apollo 7 (Mission C), Volume II - CSM Launch Aborts. MSC TN 68-FM-1770, July 19, 1968.
2. MSC; Apollo Mission Techniques, Apollo 7 Launch Phase Aborts, Techniques Description. MSC TN S-PA-8T-018, July 19, 1968.

Date: August 7, 1968

Verified by: E. M. Henderson

Rev	Item	
B	4-5	<p>Mode III aborts.</p> <p>A. Predicted <math>t_{ff}</math> after cutoff &lt; <math>1 + 40</math>.</p> <p>B. 1. G&amp;N NO-GO or full lift IP on water - do not burn.</p> <p>2. G&amp;N GO and full lift IP on land - burn to <math>t_{ff} = 1 + 40</math>, RL <math>90^\circ</math>.</p> <p>3. G&amp;N NO-GO and full lift IP on land - burn adjusted <math>\Delta V</math> from ground, cyl RL <math>90^\circ</math>.</p> <p>B. If <math>\Delta T_B \leq 2</math> sec, do not burn.</p> <p>C. If no ignition by GETI + 20 sec, burn G&amp;N until <math>\Delta R = 0</math> or specified <math>\Delta V</math>, RL <math>90^\circ</math>.</p>

## PHILOSOPHY:

- A. If the predicted  $t_{ff}$  after cutoff is less than  $1 + 40$  for a mode III burn, the computed maneuver would have to be terminated early to allow sufficient entry sequencing time. If available, the onboard  $t_{ff}$  computation is the best source to terminate the burn; if it is not available, the ground will need to adjust the burn  $\Delta V$  to avoid a  $t_{ff}$  violation.
- B. A mode III burn of or less than 2 seconds has a small effect on the landing location; see table VIII and figure 28 of reference 1.
- C. Mode III computed  $\Delta V$  is no longer valid for burn initiation delays of more than 20 seconds. Therefore, the maneuver will have to be terminated on the onboard  $\Delta R$  computation for longer delays. The effect of these delays can be seen on figure 82 of reference 2.

**COMMENT:**

The first B should be deleted from the rule. In A-1, the "or" should be changed to an "and". In A-3, "fly" should be "fly". These changes have been passed to the RFO. With these changes, the rule is consistent with current abort techniques.

**REFERENCES:**

1. Henderson, Edward M.; and Mission Operational Section, TRW Systems Group: Spacecraft Operational Abort Plan for Apollo 7 (Mission C), Volume II - CSM Launch Aborts. MSC IN 68-FM-170, July 19, 1968.

2. TRW: Apollo Saturn IB Earth Launch Phase Abort Study. TRW note 68-FMT-629, May 1968.

Date: August 7, 1968

Verified by: E. M. Henderson

Rev	Item	
B	4-6	<p>If no mode IV ignition by GETI:</p> <ul style="list-style-type: none"> <li>A. G&amp;N GO - ignite ASAP. Burn to <math>h_p = 75</math> n. mi. + 5 sec</li> <li>B. G&amp;N NO-GO - ignite ASAP. Burn ground mode IV AV.</li> <li>C. Loss of mode IV capability - ground will advise with voice, and/or abort lights. Execute mode II maneuver ASAP.</li> </ul>

#### PHILOSOPHY:

The mode IV maneuver is sensitive to the late ignitions; see figure 83, reference 1. The onboard  $h_p$  computation is the best indication of burn completion for off-nominal ignitions. The Y-V<sub>s</sub> display in the MCC will indicate when delays cause loss of mode IV capability; see reference 2. Once the mode IV attempt has been ruled unsuccessful, it should be terminated and a mode III attempted.

#### COMMENT:

The best indication of a successful mode IV burn is increasing  $h_p$ . If  $h_p$  should ever start decreasing during the burn it should be terminated; see references 3 and 4. However, the onboard display is the only  $h_p$  display available to monitor the mode IV burn. The rule is consistent with current abort techniques.

#### REFERENCES:

1. TRW: Apollo Saturn IB Earth Launch Phase Abort Study. TRW note 68-FMT-629, May 1968.
2. TRW: Contingency Orbit Insertion Capability Displayed on a Velocity-To-Go to Achieve a Safe Orbit Plotboard. TRW letter 3423.8-12, August 14, 1968.

3. Henderson, Edward M.; and Mission Operational Section, TRW Systems Group: Spacecraft Operational Abort Plan for Apollo 7 (Mission C), Volume II - CSM Launch Aborts. MSC IN 68-FM-170, July 19, 1968.
4. MSC: Apollo Mission Techniques, Apollo 7 Launch Phase Aborts, Techniques Description. MSC IN S-PA-8T-018, July 19, 1968.

Date: August 7, 1968

Verified by: E. M. Henderson

Rev	Item	The separation maneuver for contingency CSM separation from S-IVB is (Ref. 5-2):
B	4-21	<ul style="list-style-type: none"> <li>A. Impending S-IVB explosion - 4 seconds SPS ASAP</li> <li>B. Attitude rates <math>\geq 5^\circ/\text{sec}</math> - 20 seconds RCS ASAP.</li> <li>C. Yaw attitude <math>&gt; 45^\circ</math> - 20 seconds RCS ASAP.</li> <li>D. CSM deorbit required - separate 20 minutes prior to RETRO with 10 seconds RCS, Coast 30 seconds, 30 seconds retrograde RCS at horizon monitor attitude.</li> </ul>

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#### PHILOSOPHY:

- A. In the event of an impending detectable S-IVB explosion, the Crew Safety Panel recommends that the spacecraft separate to a minimum safe distance of 7080 ft. To achieve this minimum safe distance mission rule 4-21A specifies a 4-second SPS burn as soon as possible.
- B. In the event that the CSM/S-IVB attitude rates exceed 5 deg/sec during orbit, CSM separation from the S-IVB will be initiated and followed by a 20-second RCS +X translation maneuver.
- C. In the event the CSM yaw attitude exceeds  $45^\circ$ , CSM separation from the S-IVB followed by a 20-second +X translation will be executed to avoid gimbal lock.
- D. In the event that the CSM is station keeping with or attached to the S-IVB and must perform an early deorbit, the above sequence has been proposed.

#### COMMENTS:

- A. Analyses of references 1 and 2 indicate that for a warning time of 200 seconds, a 4-second SPS burn executed 6 seconds after the warning is received will result in a separation displacement in excess of 10 000 ft.

- B. CSM/S-IVB separations under tumbling conditions were analyzed in reference 3 and the results indicate that either the RCS DAP or the RCS SCS will prevent gimbal lock for attitude rates less than approximately 10 deg/sec. The 20-second RCS +X translation maneuver yields a down-range displacement of approximately 800 ft at the end of 2 minutes, thus alleviating any recontact problems.
- C. Analysis performed in reference 3 indicates that either the RCS DAP or RCS SCS control modes will prevent gimbal lock for yaw attitude rates less than approximately 10 deg/sec. The 20-second RCS +X translation maneuver yields a down-range abort displacement of approximately 800 ft at the end of 2 minutes, thus alleviating any recontact problems.
- D. The deorbit sequence of mission rule 4-21D was evaluated by the analysis of reference 4. The results indicate that if the sequence is executed precisely, the CSM will pass below the S-IVB by approximately 280 ft. If the S-IVB is assumed to have a 20-lb propulsive vent, this distance is decreased to approximately 170 ft. The relative motion of the sequence places the CSM in a favorable position for deorbit, and does not result in any recontact problems.

REFERENCES:

1. MSC: The Recommended CSM Separation Sequence for a Detectable S-IVB Impending Explosion in Orbit. MSC memorandum 67-FM37-169, May 19, 1967.
2. MSC: CSM/S-IVB Separation Maneuver for an Impending Detectable S-IVB Explosion. MSC memorandum 68-FM37-289, June 24, 1968.
3. Mission Simulation Department, TRW Systems Group; and Flight Studies Section, Flight Analysis Branch: Mission C/CSM 101 (Apollo 7) Separation and Recontact Analysis Summary Document. MSC IN 68-FM-176, July 15, 1968.
4. MSC: CSM/S-IVB Separation Maneuver Prior to Retrofire for Orbital Aborts for the D Mission. MSC memorandum 68-FM37-269, June 10, 1968.

Date: August 7, 1968

Verified by: Marland L. Williamson

Rev	Item	Non-critical SPS maneuvers will be terminated (MTVC take over and rates damped) for:
B	4-32	<p>A. <math>h_p \leq 80</math> n. mi.</p> <p>B. <math>h_a \geq 500</math>.</p> <p>C. Attitude excursion <math>\geq 10^\circ</math>.</p> <p>D. Attitude error <math>&gt; 10^\circ</math>.</p> <p>E. Attitude rates <math>\geq 2</math> deg/sec</p> <p>F. Overburn of 3-sec duration or 75 fps <math>V_c</math></p> <p>G. <math>V_g</math> increasing.</p> <p>H. System hardware failure as listed in rules <u>14-22</u>, <u>15-11</u>, <u>15-14</u>, <u>15-16</u>, <u>15-18</u>.</p>

## PHILOSOPHY:

Excursions beyond the rate and attitude limits may lower  $h_p$  to an unacceptable value. Three-second overburns also may lower  $h_p$  to an unacceptable value.  $h_p \leq 75$  n. mi. will not yield an adequate orbit lifetime.

COMMENT: Agree

## REFERENCES:

MSC: Effects of Attitude Excursion and Rates on Non-Impulsive SPS Burns for the AS-205/101 Mission. MSC memorandum 68-FM64-227, July 17, 1968.

Date: August 7, 1968

Verified by: A. H. Benney, Jr.

Rev	Item	Text
B	4-41	<p>Rendezvous plans shall, where possible, satisfy the following constraints:</p> <ul style="list-style-type: none"> <li>A. Rendezvous maneuvers through TPI must be at least 30 min apart.</li> <li>B. The allowable slip in TPI time is +18 min and -12 min from midpoint or darkness.</li> <li>C. <math>\Delta H</math> at NSR is constrained to be <u>8</u> <math>\pm</math> <u>1</u> n. mi.</li> <li>D. The maximum out-of-plane velocity correction during terminal phase is <u>  </u> fps.</li> </ul>

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**PHILOSOPHY:**

- A. Sufficient time for crew activities and program usage must be provided.
- B. Due to the possibility that the S-IVB lights may not be on, it is mandatory that the braking phase be accomplished in daylight. Therefore, it is acceptable for TPI to slip nearer sunrise than sunset.
- C. Studies have shown that expected  $3\sigma$  errors in the NCC<sub>1</sub> maneuver can be absorbed at NSR by varying the  $\Delta H$  by no more than 1 n. mi. which does not significantly affect the terminal phase (ref. 2).

**COMMENT:**

A, B, and C have been agreed upon by FCSD, FCD, and MPAD in the data priority meetings on the Apollo 7 rendezvous procedures. The D portion of the rule will be eliminated by revision C to the Apollo 7 mission rules.

REFERENCES:

1. Apollo Mission Techniques, Mission C, CSM Rendezvous, Volume I, Revision A.  
MSC IN S-PA-8T-016, August 12, 1968.
2. Young, K. A.: Changing NSR Time and  $\Delta H$  to Compensate for NCC<sub>1</sub> Errors in C Mission  
Rendezvous. MSC Memorandum 68-FM64-186, June 10, 1968.

Date: August 7, 1968

Verified by: K. A. Young

Rev	Item	The order of priority for TPI solutions is G&N, backup charts, ground. The onboard TPI solutions will not be used if different from the ground by:
B	4-42	A. GETI $\pm$ <u>4.5</u> min
		B. F/A $\pm$ <u>2</u> fps
		C. L/R $\pm$ <u>3</u> fps
		D. U/D $\pm$ <u>3</u> fps

PHILOSOPHY:

Every reasonable attempt will be made to allow the onboard G&N solution to be used to evaluate the CSM's independent ability to rendezvous. Thus the limits on the TPI solution are fairly wide.

COMMENT:

These limits were agreed upon by FCSD, FCD, and MPAD in the Apollo 7 data priority meetings.

REFERENCE:

1. Apollo Mission Techniques, Mission C, CSM Rendezvous, Volume I, Revision A.  
MSC IN S-PA-8T-016, August 12, 1968.

Date: August 7, 1968

Verified by: K. A. Young

Rev	Item	
B	4-43	<p>A. If <math>\text{NCC}_1</math> residuals are greater than <u>10</u> fps, no trim will be applied.</p> <p>B. If <math>\text{NCC}_1</math> residuals are <u>&lt; 10</u> fps, trim to <u>10</u> fps.</p>

#### PHILOSOPHY:

Studies have shown that if residuals are trimmed there is virtually no chance of having to perform an  $\text{NCC}_2$  corrective maneuver, since the technique of varying  $\Delta H \pm 1$  n. mi. should handle the remaining dispersions. If residuals are greater than 10 fps, however, it will save RCS propellant to not trim and perform an SPS  $\text{NCC}_2$  maneuver instead.

#### COMMENT:

This reasoning was agreed upon by FCSD, FCD, and MPAD in the Apollo 7 data priority meetings.

#### REFERENCE:

- Young, K. A.: Changing NSR Time and  $\Delta H$  to Compensate for  $\text{NCC}_1$  Errors in C Mission Rendezvous. MCS Memorandum 68-FM64-186, June 10, 1968.

Date: August 7, 1968

Verified by: K. A. Young

Rev	Item	RCS nulling, for dispersions resulting from $NCC_2$ and NSR, will reduce $V_g$ residuals to:
B	4-44	$V_{gx} \leq \frac{0.2}{fps}$
		$V_{gy} \leq \frac{0.2}{fps}$
		$V_{gz} \leq \frac{0.2}{fps}$

PHILOSOPHY:

Since there are no corrective maneuvers to adjust for  $NCC_2$  and NSR errors prior to TPI,  
 it is essential that the residuals be trimmed to prevent undesirable effects on the  $\Delta H$   
 and TPI time and  $\Delta V$ . Therefore, all components should be closely controlled.

COMMENT:

This rule has been agreed on by FCSD, FCD, and MPAD in the Apollo 7 data priority meetings.

REFERENCES:

None

Date: August 7, 1968

Verified by: K. A. Young

Rev	Item	
B	4-52	Planned G&N and SCS retrofire maneuver will be updated if: A. The computed retrofire position changes by $> 0.5^\circ$ longitude prior to GETI - 30 min. B. The computed retrofire position changes by $> 2^\circ$ longitude after GETI - 30 min.

**PHILOSOPHY:**

- A. Allows approximately a 30-n. mi. miss distance to occur before an onboard navigational update should be made.
- B. States that within 30 minutes of retrofire, when the crew activity and ground communications are critical, the onboard navigation vector will not be updated unless the target position changes by approximately 120 n. mi.

COMMENT: None

**REFERENCES:**

Tindall, H. W.: Apollo Mission Techniques Mission C (AS-205/101) Retrofire and Reentry Volume I Techniques Description. MSC IN S-PA-8-T-011, September 6, 1968.

Date: August 7, 1968

Verified by: David W. Heath

Rev	Item	
B	4-53	If a G&N failure is detected prior to retrofire, crew uses SCS ΔV mode with GETI for 55/55 entry.

PHILOSOPHY:

This assumes the EMS is functional and operating correctly. If the EMS is "go" then this procedure is the targeting scheme.

COMMENT:

At the present time the EMS onboard the Apollo 7 C/CSM-101 has an intermittent failure in the EMS range-to-go counter circuit. This makes the EMS ranging capability unreliable. Therefore, if the G&N fails prior to retrofire, it is recommended that the CM be targeted for a ballistic reentry and appropriate pad data be passed from the ground.

REFERENCES:

1. Tindall, H. W.: Apollo Mission Techniques Mission C (AS-205/CSM-101) Retrofire and Reentry, Volume I, Techniques Description. MSC IN S-PA-8-T-011, March 6, 1968 and September 6, 1968.
2. Flight Analysis Section, TRW Systems Group: MSC/TRW Reentry Monitoring and Backup Control Procedures for Near Earth Orbital Missions. MSC IN 68-FM-178, July 24, 1968.

Date: August 7, 1968

Verified by: David W. Heath

Rev	Item	
B	4-54	If SPS fails after ignition or no SLA separation: A. $h_p < 75$ n. mi. - retarget for next best PTP with RCS B. $40 < h_p < 75$ - pitch up $50^\circ$ from retro attitude, burn SM/RCS until $h_p < 40$ n. mi.; if $t_{ff} > 7$ min, continue burn using allowable fuel; or $t_{ff} = 7$ min, CM/RCS may be used to reduce $h_p$ to 40 n. mi. Fly RL 90 entry. C. $h_p < 40$ n. mi. - burn SM/RCS in SPS attitude to put target in the footprint (crew charts).

## PHILOSOPHY:

- B. The important criteria is to get the CM below the overshoot boundary as defined in mission rule 2-8B to ensure a safe reentry condition.
- C. The crew is provided with onboard charts (ref. 2) to determine how much apparent target shift the deorbit burn has caused.

## COMMENT:

Note that the 40  $h_p$  number is really a number passed up by ground for each particular deorbit situation.

## REFERENCES:

1. Hill, O.: Recommended Hybrid Deorbit Procedures and Final Propellant Budget. MSC memorandum, to be published.

2. Flight Analysis Section, TRW Systems Group: MSC/TRW Reentry Monitoring and Backup Control Procedures for Mission C/CSM-101 (Apollo 7). MSC IN 68-FM-213, August 15, 1968.

Date: August 7, 1968

Verified by: David W. Heath

Rev	Item	
4-60		The G&N is NO-GO for entry if:  A. CMC value of downrange error ( $R_p - R_T$ ) at .2g differs $> \pm 75$ n. mi. from ground value for $> \pm 115$ n. mi. from backup chart value. Crew failover to EMS entry at first priority or ground bank angle and RETRB as second priority.  B. $V$ and $\gamma$ at 400K are outside corridor. Ground will provide entry profile.

#### PHILOSOPHY:

- A. There is a need to verify the CMC's steering command prior to executing the reentry. This is presently done at 0.2g based upon the DSKY displayed value of downrange error (DRE) in register number 3 of P67. If the onboard DSKY display is within tolerances, the CMC is "go" for reentry, if not, the appropriate backup mode should be used.
- B. Presently there are only two relative checks that the crew can make about the deorbit maneuver that will indicate whether they are outside the reentry corridor, namely the  $\Delta V$  g residuals, and the CMC calculated  $h_p$  after the burn. Neither quantities tell the crew quantitatively where they are in the corridor and what reentry profile should be flown; therefore, ground is prime.

#### COMMENT:

- A. The tolerance between the postburn DRE past from ground is now  $\pm 100$  n. mi. and from the onboard chart the value is  $\pm 130$  n. mi. as stated in the references. The crew has also requested a CMC ground and EMS check at RET 0.05g be use to determine whether the CMC and/or the EMS are functioning properly. This last CMC/EMS check at present has no written mission rule.

**REFERENCES:**

1. Tindall, H. W.: Apollo Mission Techniques Mission C Retrofire and Reentry, Volume I, Techniques Description Revision A. MSC IN S-PA-8-T-011, September 6, 1968.
2. Flight Analysis Section, TRW Systems Group: MSC/TRW Reentry Monitoring and Backup Control Procedures for Mission C/CSM-101 (Apollo 7). MSC IN 68-FM-213, August 15, 1968.
3. Hill, O.: Reentry Data for Retrofire and Reentry Mission Technique Document. MSC memorandum 68-FM-132, to be published.

Date: August 7, 1968

Verified by: David W. Heath

Rev	Item	<u>CRYO MANAGEMENT</u>
B	10-31B	<p>B. Additional power loads and/or additional fuel cell purges will be used as required to monitor tank pressures below the relief point of tank relief valves (95° PSID O<sub>2</sub>, 270 PSID H<sub>2</sub>.)</p>

#### PHILOSOPHY:

The reason for this rule is to prevent cracking of the relief valves. These valves have metal-to-metal seats which causes some doubt as to whether the valves would reseat if ever cracked. Impurities in the cryogenic gases could become lodged in the valves which would result in continuous venting.

#### COMMENT:

Since venting appears to be inevitable, the rule loses its meaning. Present calculations predict that once venting starts, it will continue until CM/SM separation. Revision C to the Apollo 7 mission rules eliminates the above rule.

#### REFERENCE:

1. Scott, W.: Cryogenic Quantities Required at Lift-Off for C, D, and E Missions.  
MSC Memorandum 68-FMT4-372, August 20, 1968.

Date: August 7, 1968

Verified by: W. Scott